circuit is first broken. It will, however, soon reach a state of equilibrium and remain nearly constant.

The change in temperature required to make and break the circuit varies with the form and size of the regulator used and its contents. In the mercury regulator constructed as represented in Fig. 1 it is less than one half degree. In the regulator made as represented in Fig. 2, containing glycerin and mercury, it is less than one tenth degree. If air is substituted for glycerin, the regulator is still more sensitive, but the temperature maintained varies nearly two degrees with extremes in barometric pressure. Barometric changes, however, affect the liquid regulators but very little. If water and air are substituted for mercury and air, the temperature variation is slightly increased.

The advantage of glycerin toluole and chloroform over mercury lies in the fact that they have a much higher index of expansion than mercury and, at least glycerin and chloroform, are much cheaper.

Both forms can be made more sensitive, (1) by increasing the length of the chamber containing the mercury, glycerin or other substances, (2) by increasing the diameter of the tube near the electric end so as to admit the use of a longer lever, (3) by increasing the ratio between the diameter of the tube and that of its constriction. (A constriction can be made use of in the glycerin regulator as well as in the one containing only mercury.) It will thus be seen that there is theoretically no limit to the possible sensitiveness of these regulators.

A glass tube having an inside diameter of 7 mm., reduced to 2 mm. at the constriction, was found to be suitable for the construction of these regulators. In making the constriction the tube should be heated and rotated until the walls fall in before it is drawn out, so that they will become thick and the tube will be strengthened at this otherwise weak point. No special care need be exercised in bending the tube; various other forms than those represented will answer the purpose just as well.

Either form of the regulators described can, of course, be used in connection with "heating coils," such as described by Professor Mark or others, or in connection with incandescent electric bulbs. The latter are usually furnished without charge by electric power and lighting companies. They serve the purpose fairly well, although some inconvenience must be expected, owing to the liability with which they burn out, unless several are used in heating each bath.

In case bulbs are used and apparatus is constructed with this in view, I think metal tubes large enough to admit a bulb should be soldered in the side near the bottom. If the cylindrical form of bulb is used these need not be large. The tubes should be dead black inside and closed after the lamps are in. In this way practically all the light energy is transformed into heat energy.

Heating with electricity is somewhat more expensive than heating with gas. I was, however, surprised to find that a sixteen-candle power incandescent lamp, with the circuit broken nearly three fourths of the time, will maintain a temperature between fifty and sixty degrees in a well-insulated bath which holds about one liter.

S. O. Mast
Johns Hopkins University

SEISMOGRAPHS IN UTAH

It may be of interest to many to know that seismographic apparatus has recently been installed at the University of Utah. The university campus covers part of a shore terrace built by the Pleistocene water-body known as Lake Bonneville on the easterly outskirts of the region now occupied by Salt Lake City, and lying practically at the base of the Wasatch range. The Wasatch Mountains are of immature age, and consequently are now rising. Raw scarps at the foot of a spur just northeast from the city, and similar scarps at the base of the main range a short distance to the southeast, tell of comparatively recent up-slips of these sections of the mountain mass. At the Wasatch base directly east from the city, along the line of the bench-land junction with the mountain mass, there is little

evidence of fault movement at all comparable as to recency with the fresh scarps northerly and southerly from the locality described.

This fact and others of related significance have inspired the prediction that the next or at least a relatively early orogenic uplift in this section of the Wasatch terrane will result in a break to the east from Salt Lake City, with accompaniments of destructive earthquakes.[1]

The foundation of this prophecy of assured calamity has been questioned by the writer.[2]

It is a fact that slight earth tremors occur at frequent intervals in the Salt Lake Valley. These tremors originate differently, mainly as follows: (1) in orogenic slips incident to the rise of the Wasatch mass, or, more precisely, incident to the upward slip of some particular section of the range, since the mountain mass does not move as a whole; (2) in the slips incident to the readjustment of the monoclinal crust-blocks composing the Basin Ranges to the west. These conditions of crustal movement in this vicinity warrant the statement that sesimographic records here obtained promise results of both interest and value.

The writer is pleased to report the installation of a pair of seismographic pendulums in Utah. The apparatus as a whole may be designated as the Omori-Bosch seismograph. It was imported from Bosch, Strassburg.

Before deciding on the purchase of this type of apparatus, the writer inquired by correspondence and personal visits as to instruments for recording earth movements now in operation in this country. The results showed but few installations, and, according to the reports, a considerable number of these were of doubtful efficiency.

The Omori-Bosch seismograph includes a weight of 100 kilograms suspended by a flexible wire and supported in part by a cone and socket attachment extending from an iron column four and a half feet high, said column being firmly anchored to a massive pillar rising from a deep foundation and isolated from floor and other surface contact. Attached to the weight is a skeleton cone of aluminum rods, which, with frictionless attachments, operates a fine recording pen or point. The tracing point rests on the surface of a paper-covered revolving drum. The paper is glazed on one side, and when placed in position on the drum is lightly smoked.

A reliable contact clock is electrically connected with the recording mechanism, and a metallic point projecting from the armature of an electro-magnet makest its imprint upon the smoked paper at intervals of minutes or seconds. The record during a period free from earth tremors is a series of uninterrupted lines with dots indicating time intervals; disturbances are shown by cross tracings, of wide amplitude and short duration when caused by superficial jarring of the instrument, but smaller as to amplitude, and otherwise distinctively different if caused by an earth tremor reaching the pillar from below.

The equipment at the University of Utah comprises two instruments as described; these are set respectively on the north-south and east-west lines. One clock makes synchronous record on each of the two drums.

The sensitiveness of the apparatus is surprising. A blast from the human lungs impinging upon the side of the supporting pillar is definitely recorded. A heavy hammer blow on the end of the pillar, if delivered on the line of the main axis—north-south or east-west according to the pillar that is struck—makes no tracing beyond that due to a slight upward jolt of the recording pen and the return of the point perhaps a little out of its normal position.

Each instrument is mounted on a pillar or pier of concrete, extending about 15 feet below the floor. The entire apparatus is enclosed within a tight case with glass sides.

On July 2 a powder explosion occurred about three miles from the university grounds. The explosive was fired while packed in freight cars awaiting removal to the magazine buildings near by. According to report 725 kegs of blasting powder and a ton of giant

[1] See Lake Bonneville, by G. K. Gilbert, Monograph I., U. S. Geol. Surv., pp. 361, 362.

[2] *Scottish Geographical Magazine*, September, 1902.

powder exploded. The cars were blown to bits, rails were broken and warped and the pieces were hurled to great distances; houses in the vicinity were wrecked; and the force of the explosion was felt throughout the city. The seismographs recorded the surface movement as a cross tracing, distinct but susceptible of measurement only with the aid of a lens.

J. E. Talmage

MASS AND ENERGY

The following is an outline of some interesting theoretical results, a full account of which will shortly appear elsewhere.

If a piece of matter be considered as an electrical system, possessing any structure or internal motions, but having on the whole a kind of average symmetry, then it may be shown that the electromagnetic mass of such a system for ordinary velocities is given by

$$\text{Mass} = \frac{4}{3}\frac{1}{V^2}E$$

where V is the velocity of light and E is the total electromagnetic energy of the system. Thus the mass of the system is determined solely by its energy content, and the idea is suggested that mass and energy may have something in common. This result has several interesting implications.

Any reaction which is caused by the action of electric forces will involve a change in the electromagnetic energy content of the system, and hence according to the above view will be accompanied by a change of mass. This change will, of course, in general be a decrease. In the case of ordinary chemical reactions calculation shows that this change would be too small to be detected, but in the case of radioactivity, where the energy lost is relatively much greater, a sensible change is to be expected. Thus on this view the atomic weight of the various products of radium can not be accurately calculated from the number of α-particles lost, for there is this further decrease in mass due to the loss of energy.

The evolutionary theory of the elements has always met an almost insuperable difficulty in the fact that there appears to be no *exact* regularity of any kind throughout the list of atomic weights.

Some years ago Rydberg came to the conclusion that it was necessary to consider the atomic weights, up to that of iron, as made up of two distinct parts $N + D$, where D is a very small difference, a slight deviation in fact from (N). Exact harmonious relations exist between the various N's and Rydberg seems to consider the D's as representing real physical deviations and not merely mathematical remainders.

From the point of view of loss of mass accompanying energy dissipation, it is evident that these small irregularities are just what is to be expected.

Finally it is to be noticed that if for all matter the ratio of mass to weight is sensibly the same, the above mentioned proportionality between mass and included energy can only imply that the gravitation of a body is always proportional to its total energy content, and this constant proportionality seems to point toward the conclusion that it is confined energy which gravitates and not mass in any other sense.

It is perhaps well to point out that the conclusion respecting gravitation involves the assumption that all the mass of matter is electromagnetic, while the conclusion respecting loss of mass and atomic weight irregularities requires only that the forces causing the energy change be electric or magnetic, *i. e.*, requires only that *part* of the total mass be of electromagnetic origin.

Daniel F. Comstock
Mass. Institute of Technology,
September 9, 1907

NOTES ON ENTOMOLOGY

Another heavy installment of Wytsman's "Genera Insectorum," has made its appearance. Fascicle 46[c] by Otto Schwarz completes the Elateridæ or click beetles; it comprises pages 225 to 370, and six colored plates. The types of the genera are not indicated, and the references are incomplete. In the case of new genera there is nothing to show